REMARKS

Applicant has amended the claim 8 and added new claims 20 to 23. Applicant respectfully submits that these amendments to the claims are supported by the application as originally filed and does not contain any new matter. Accordingly the Office Action will be discussed in terms of the claims as amended.

The Examiner has rejected the claims 8 and 15 to 19 under 35 USC 102 as being anticipated by Sasaki stating that Sasaki discloses a method for generating/displaying a plane shape which includes all of the elements of the present invention.

The present invention solves the problems of the structural deficiencies seen in prior patents which are that as the number of divisions increases, the accumulating errors in shape generating increases; and it discloses a new scheme which is a rational and innovative technology that is free of errors in shape creation.

In reply to this rejection, Applicant would like to first point out that the present invention employs a shape creating system with a hyperplane structure which is a shape generation based on plane structures that have not seen previously. The hyperplane is one that divides a space into two; and the hyperplane of a three-dimensional space is a flat surface, the hyperplane of a two-dimensional space is a straight line, and the hyperplane of a one-dimensional space is a point. A hyperplane is a composition of an object entity in a space. The relationship between this hyperplane and the present invention is written in the specification in regards to a normal line of a tangent plane on an entity.

In contrast to Applicant's invention, Sasaki merely relates to simple planar divisions, being different from the present invention which is for recursive spatial divisions, and the scheme and method in Sasaki are inherently different entirely from the present invention. In particular, the present invention relates to a shape generating or shape creating system; however, Sasaki relates to rendering based on line structures. In Sasaki, assumption of normal lines is simple, and thus Sasaki discloses a system that has nothing to do with the present invention. In other words, Sasaki relates to mere decisions of simple plain normal lines that are on a same plane, and thus Sasaki is entirely different from the present invention that relates to a normal line employed as a hyperplane.

Still further Applicant respectfully submits that the spatial divisions of the present invention is a decomposition of a spatial structure as a recursive method, and each of the divided patch is again divided and re-divided using the same dividing method.

Figure 1(A) below is an example showing a one time spatial division in the repeating divisions, wherein a triangular patch is spatially divided into four triangular patches, each respectively having different plane directions, thus forming a three-dimensional shape as a new curved surface.

Figure 1(B) below is an example showing the re-division in the spatial divisions, the created triangular patches are again spatially divided.

Applicant respectfully submits that in these examples, one time division generates four spatial triangular patches, and in the next, second time division, sixteen triangular patches that are arranged spatially are generated to form a three-dimensional shape.

This repeat of the spatially division is called a power-of-four division with the number of repeat being the index. Thus, the spatial divisions are executed sequentially and recursively. In this sequential and recursive division, the hyperplane that becomes a tangent plane for the essential curved surface is decided. In other words, in Applicant's invention an intended (object) curved surface is decided by the position and direction of a normal line that is equivalent to a hyperplane.

For the benefit of the Examiner to more easily understand Applicant's invention and by way of example, set forth below in detail is a method for forming an intended (object) curved surface in accordance with Applicants invention as follows:

An intended (object) curved surface can be formed as an envelop surface by tangent planes. In the present invention, by way of determining the position and direction of a normal line indicative of hyperplane equivalent to a tangent plane, an intended (object) shape is structured. In other words, as an utmost limit of repeated spatial divisions, a curved surface can be formed as a collection of the positions of normal lines that are equivalent to hyperplane. This should be clear from the fact that triangular patches obtained by divisions become points for forming an intended (object) curved surface in a manner of shift from plane to point as an ultimate limit.

The normal line of a hyperplane that is represented as a tangent plane of a point of an intended (object) curved surface is the respective normal lines existing at vertexes

of a triangular patch that is to be divided; and respective normal lines facing each other are decomposed to decide a boundary curved line existing between two vertexes; and with the extreme value, for example, the maximum value, of the curved line being the respective vertexes of the triangular patch to be divided, such vertexes are set as the position of an intermediate normal line at the vertexes of the triangular patch to be divided, and a spatial re-division is executed.

In other words, the position of the obtained intermediate normal line makes the vertex of a new triangular patch for executing spatial re-division.

The above is described in the specification as the method shown in the filed Figure 2.

The direction of the intermediate normal line that is a dividing point is decided in the shape of a line.

Another method for deciding the normal line is disclosed in the specification of the application.

Lastly, as an example of spatial decomposition, a result of verification obtained by a simple experimental system that is formed as a prototype is shown in Figure 3 below

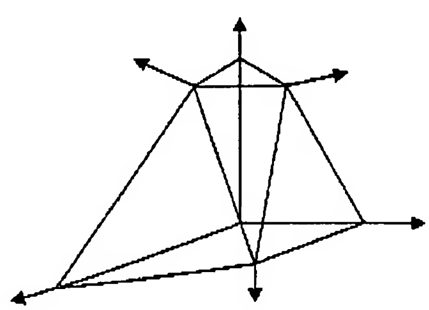
Figure 3 below shows an example in which the spatial divisions repeated for six times.

In this example, spatial division for forming a three-dimensional shape is realized at high speed and precisely, showing the superiority of the invention.

Figure 1 Dividing Process of Polyhedron Patch using Intermediate Normal Line

Curved surface based on asymptotic process using asymptotic polyhedron

(A) Dividing Number of Triangle Patch One



(B) Dividing Number of Triangle Patch Two

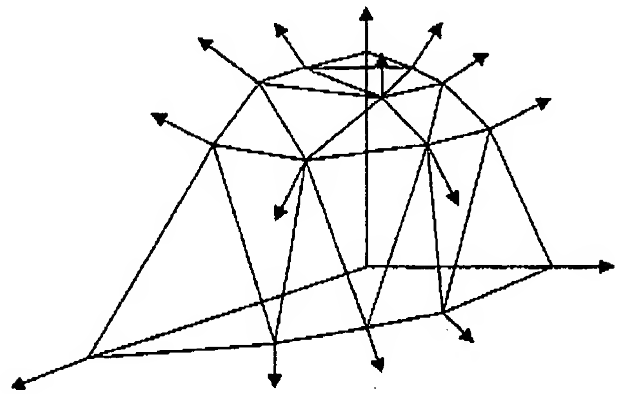
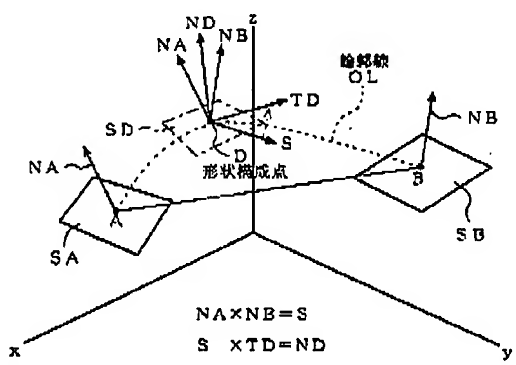


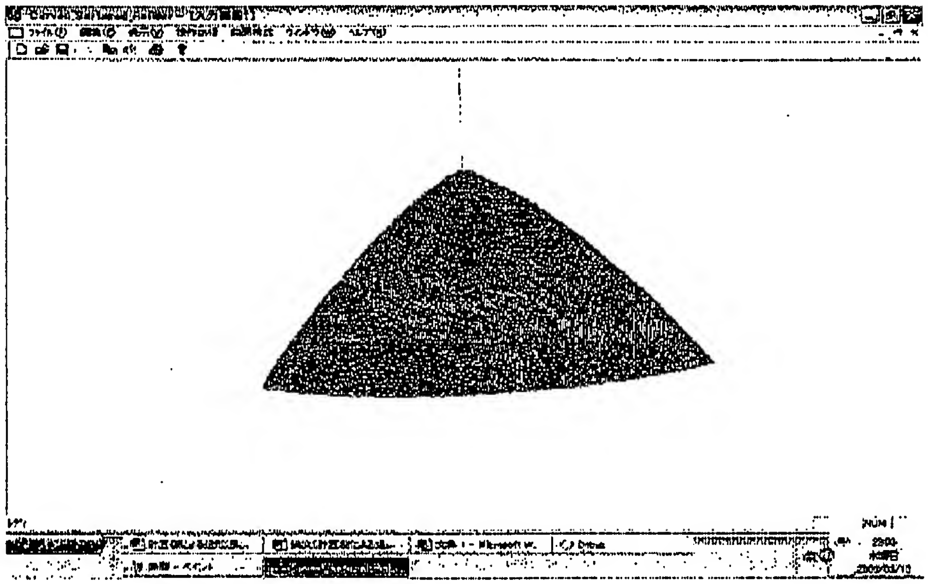
Figure 2 Setting of Intermediate Normal Line by Polyhedron Forming Patch

Structure of intermediate hyperplane formed by position and direction of set intermediate normal line



Japanese above "OL" : Contour
Japanese below "D" : Shape constructing point

Figure 3 Example of Intended (object) Curved Surface by Prototype Verification System (Decomposing Level: 6)



Still further, Applicant would like to point out that forming a polyhedron is not the ultimate goal, and the object is to form a curved surface as a polyhedron. The polyhedron in the present invention is not a mere polyhedron but is an asymptotic polyhedron that can become closer to an intended (object) curved surface without limitation, and this asymptotic polyhedron is used to form a curved surface. In other words, in the shape creating process of the present invention, an asymptotic polyhedron reaches the intended (object) curved surface and conforms thereto as its limitation.

Therefore the point of the invention of the present application is not an approximate creation or expression of a curved surface by non-structural polyhedron in which plain triangle patches are merely arranged. In the present invention, a triangle patch that is oriented in an arbitrary space is recursively repeated as spatial re-divisions, and as a result of repeated divisions, a polyhedron converges to a curved surface and ultimately conform thereto as its limitation. As a result, the divided triangle patches function as structural polyhedron or asymptotic polyhedron to form curved surfaces.

Applicant further respectfully submits that by sequentially and recursively using a triangle shape plane patch which is a polygonal shape to generate a polygonal shape model, an asymptotic polyhedron can be formed as a structured polyhedron; as a result, at its terminal

end, it converges into a true curved surface without any error. Accordingly, with the present invention a method is provided in which:

1 It is possible to display at high speed a curved surface.

2 It is possible to display at high efficiency a curved surface.

3 It is possible to accurately display a curved surface.

4 It is possible to display any curved shape.

In the prior art of shape generation and creation that uses computers, shapes are expressed by crossing points of two curved lines of two directions on a curved surface. Accordingly, the role of shape forming seeks the tangent lines of two curved lines of two directions that forms a curved surface. We call this a tangent line system.

Naturally, as a result, the normal line sought in a rendering method in computer graphics is decided by a tangent line of two curved lines of two directions. Accordingly, since this method utilizes tangent lines to determine a normal line, the role of the normal line is based on a arrangement of tangent lines.

In contrast thereto, the invention of the present application is to accomplish the object by a position of a hyperplane or a tangent plane of a curved surface and a direction of a normal line passing there through. As a result, in the present invention, normal lines play the main role. Thus, the present invention is a normal line system, differentiating it from the existing tangent line system of the prior art.

Still further in Applicant's invention, a normal line existing there is determined by boundary normal line given to the vertex of the triangle patch. With respect to each of the vertexes of the triangle patch, each of the boundary normal lines of the triangle patch is decomposed, determining the shape of boundary cross-section of the corresponding vertex, and by adding maximum or minimum vertex, a new polyhedron is created. This is an asymptotic polyhedron.

Accordingly, for each of the triangle patches divided and formed, like the previous steps, tangent lines are obtained by decomposing normal lines which are at each of the vertexes of the patch, determining tangent lines corresponding to the respective vertex directions, and determining a cross-sectional shape of a curved surface in that direction by curved lines. By a repetition of this, a position of the tangent plane is obtained, forming a curved surface.

The detail will be described with reference to the Attached Figure.

Clearly being different from the existing method that shows a curved surface with crossing points of two curved lines, the present invention displays a curved surface as a position of a tangent plane. With this method, a curved surface can be created asymptotically, and curved surfaces can be displayed speedy and efficiently and accurately

In view of the above, Applicant respectfully submits that Sasaki does not show each element of Applicant's invention and cannot achieve the advantages of Applicant's invention, namely the speedy, efficient and accurate display of curved surfaces. Therefore, Applicant respectfully submits that the claims are not anticipated by Sasaki.

For the newly added claims 20-23, please charge $220.00 to cover the fee for the independent claims in excess of three, $156.00 to cover the fee for the claims in excess of 20 and $195.00 to cover the fee for the multiple dependent claims to QUINN EMANUEL Deposit Account Number 50-4367.

Applicant respectfully and retroactively requests a three (3) month extension of time to respond to the Office Action and requests that the extension fee in the amount of $555.00 be charged to QUINN EMANUEL Deposit Account Number 50-4367.

In view of the above, it is respectfully requested that this Amendment be entered, favorably considered and the case past to issue.

Please charge any additional costs incurred by or in order enter this amendment or required by any requests for extension of time to Quinn Emanuel Deposit Account No. 50-4367.

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01 FC:2614 220.00 DA
02 FC:2616 195.00 DA
03 FC:2615 156.00 DA

Respectfully submitted,

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